[*Discovery Reports. Vol. II, pp.* 371–402, *Plates III and IV, text-figs.* 1–18, *November*, 1930.]

CEPHALOPODA, I. OCTOPODA

By

G C. ROBSON, M.A.

CONTENTS

CEPHALOPODA, I. OCTOPODA

By G. C. Robson, M.A.[1]

(Plates III and IV, text-figs. 1–18)

INTRODUCTION

The Octopoda obtained by the 'Discovery' form a rich and important collection. Fifty-nine specimens were obtained, representing fourteen species. Of these the majority were taken in sub-Antarctic or Antarctic waters, the collection being the richest ever obtained in these latitudes.

The series is of more than ordinary interest from the systematic and distributional point of view. The chief items of interest may be presented under two heads.

1. The expedition obtained a number of rare pelagic Octopods belonging to various families. The most important of these are a single male of a new species of *Vitreledonella*, and one specimen each of the rare genera *Alloposus* and *Amphitretus*, both constituting the types of new species. A new and remarkable species of *Cirroteuthis* was obtained, for which a separate genus may ultimately be required.

2. Perhaps the most valuable outcome of this study is the flood of light cast on the genus *Eledone* by the plentiful supply of specimens which were obtained by the expedition. No less than forty-three specimens of this characteristic Antarctic group were obtained, representing four species. Two of these species are new, and for one of these a new genus is created.

The study of these forms confirms me in the belief that the Antarctic is, as Berry (1917, p. 13) suggested, the metropolis of this group. It is absent from nearly the whole of the Indo-Pacific and Aleutian regions, and is rather sparsely represented in North Atlantic waters.

Naef has questioned whether the genus as known to him might not be polyphyletic. Study of the Discovery material and a re-examination of the types of Hoyle's 'Challenger' species has rendered it most probable that Naef's suggestion is correct. The Mediterranean and Antarctic forms are shown to be radically dissimilar in several important characters, and it seems more likely that the single row of suckers (the only common feature[2]) has been acquired independently on two or more occasions. Furthermore, the group of sub-Antarctic and Antarctic forms is not homogeneous. *Graneledone* (represented by *G. charcoti*, etc.) is very distinct from *Thaumeledone* and *Eledone rotunda* from further afield but possibly having a sub-Antarctic range. Berry's *E. challengeri* (Kermadec Is.) (= "*verrucosa*," Hoyle, 1886) seems to require recognition in a separate genus on account of its archaic radula. *Thaumeledone* and *Eledone rotunda* both

[1] Published by permission of the Trustees of the British Museum.

[2] It is not yet certain how many species of *Eledone* share with *E. cirrosa* and *moschata* the characteristic of depositing large eggs.

lack ink-sacs (as in the Bathypolypodinae). At present it is impossible to say whether the Bathypolypodinae are a natural group and whether *Thaumeledone* and its fellow are Bathypolypods that have independently acquired a single row of suckers, or whether (as I am strongly inclined to suspect) the Octopodidae are in a very active evolutionary stage (Robson, 1929, p. 4), out of which large and natural subdivisions have not yet been evolved and stabilised, so that the ink-sac has been lost and the suckers have become uniserial on more than one occasion. These are highly interesting matters which I hope to discuss at fuller length in a subsequent publication.

One of the most interesting phenomena that have been revealed from the study of the Discovery material is the degeneration of the radula of *Thaumeledone gunteri*. Other forms were examined, and a similar state of affairs was found in Hoyle's *Eledone brevis*. In both these species the radula consists only of the median tooth, vestiges of a lateral being detected in *T. gunteri*. These forms represent the end term of a progressive reduction in the outer teeth seen in *E. rotunda*, *E. polymorpha* and certain Bathypolypods. We are irresistibly reminded of the complete loss of the radula in the Cirromorpha. But it remains to be seen what the significance of the reduction and loss of the radula in these forms may be, and whether the loss of the lateral teeth in *Thaumeledone* is a stage in a process of general atrophy, or if it merely represents a progressive concentration of the process of mastication on the median tooth. In favour of the latter, it should be pointed out that the median is very strong and solid in *Thaumeledone*. It may be recalled in this connection that groups of other Mollusca show a similar process of reduction to a single strong tooth, e.g. some Aeolididae and *Elysia* among Opisthobranchs, some Rachiglossa among the Streptoneura and *Chaetoderma* among the Amphineura.

It is a source of great pleasure to record the excellent state of preservation of these specimens. Octopoda of all kinds are usually a source of great trouble to the taxonomist. Contraction, distortion, discoloration and effacement of the epidermal "sculpture" have usually made the task of specific diagnosis unusually difficult. The Discovery specimens, however, are in magnificent condition, even the delicate pelagic forms being little distorted.

NOTE. Certain measurements are given herein in the form of index-numbers in accordance with the system used in a comprehensive work on Octopod classification (Robson, 1929, pp. 24 *seq.*, 38, 42). They may be briefly indicated as follows:

1. Width, index $= \dfrac{\text{maximum width of mantle} \times 100}{\text{length, eyes to apex of mantle}}$.

2. Head, index $= \dfrac{\text{interocular width} \times 100}{\text{length (as in 1)}}$.

3. Arms, index $= \dfrac{\text{maximum arm length} \times 100}{\text{total length}}$.

4. Suckers, index $= \dfrac{\text{diameter of largest sucker} \times 100}{\text{length (as in 1)}}$.

5. Web, index $= \dfrac{\text{depth of deepest sector (edge to mouth)} \times 100}{\text{maximum arm-length}}$.

SYSTEMATIC

Order OCTOPODA, Leach

Sub-order *CIRROMORPHA*, Robson, 1929

Cirroteuthis glacialis, n.sp.

St. 182. 14. iii. 27. Schollaert Channel, Palmer Archipelago. 64° 21′ 00″ S, 62° 58′ 00″ W. 278–500 m., mud. Large otter trawl: one ♂.

Dimensions (in mm.).

Eyes—mantle apex	78	Web, depth, in Sector A	148
,, —edge of web (between dorsal arms)	140	,, ,, ,, B	136
Interocular width	80	,, ,, ,, C	116
Body, maximum width	58	,, ,, ,, D	92
Fins, length	75	,, ,, ,, E	66
,, width	54		
Arm (left), length:			
1st	200		
2nd	195		
3rd	185		
4th	175		

The general appearance is characterised by the extraordinarily deep and heavy fins and the relatively short body and wide head. It is really unlike that of any known species, though in general outline it recalls *C. megaptera*, Verrill (Joubin, 1920)[1]. The arms are in the order 1, 2, 3, 4. The longest bear about seventy-four suckers. The first fourteen to seventeen suckers are very deeply sunk in the surface tissues. When sectioned they are found to be very muscular, the inferior chamber and suctorial surface being exceptionally well developed. This fact, considered in relation to the feebleness of the suckers of some deep-water Octopods, renders the problem of the adaptation of these animals extremely baffling (*v.* anon).

The cirrhi are disposed as usual. They do not exceed about 5·5 mm. in length, and the proximal and distal ones become very minute. The web is of the pattern A, B, C, D, E. E is well under half the depth of A, a remarkable feature. The head is large, and wider than long. The eyes are $\frac{1}{9}$ of the area of the mantle, and are thus of relatively moderate size (Robson, 1926, p. 1349). The fins are very large. Unlike such forms as *C. magna* and *megaptera*[2], in which the fins are also very large, the base is nearly the widest part and is not narrow, as in those species. The striking thing about the fins is their very great depth, which is over $\frac{2}{3}$ of the length from the eyes to the apex of the body. The surface tissues are, as usual, gelatinous, but the general consistency is firmer and more solid than usual. The head and arms and the dorsal surface of the mantle are of a fine bluish purple. The fins and under-surface of the body are more of a reddish tint. A very

[1] It is not at all like the original specimen of *megaptera* (Verrill, 1885, pl. xliii, fig. 1). It resembles a specimen taken in 16° 12′ N, 24° 43′ W and named *megaptera* by Joubin (*loc. cit.*). Very unfortunately Joubin did not describe this example in detail and I am quite unable to say if it is rightly named. Though it resembles this specimen in general proportion, the 'Discovery' example differs from it in the size and shape of its fins.

[2] In Joubin's *megaptera* (*loc. cit.*) the sides of the fins seem to be parallel.

peculiar feature of the oral surface is that the arms and web are coloured the same purple hue, except for a circular band of paler colour about 30 mm. deep, which passes round the mouth at the level of the 14th to the 20th sucker. The oral surface of the arms (but not of the suckers, which is ochreous) preserves the purple shade[1].

The mantle-aperture is very narrow; but it is still to some measure free of the funnel, and not in contact with it at its side. The temporary adhesion of the funnel to the mantle-rim is, however, very perfect. The surface of the funnel is excavated to receive the

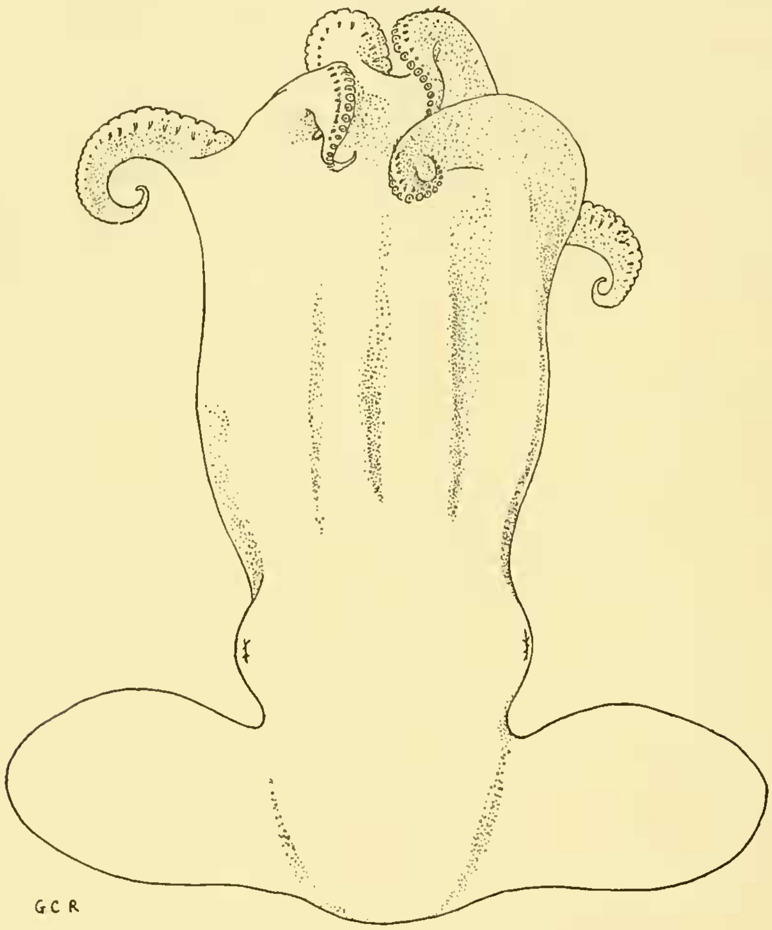


Fig. 1. *Cirroteuthis glacialis*, n.sp. × 1.

mantle-edge and the two elements of the locking apparatus are very well developed. The cephalic element is singularly well developed, especially laterally. In fact I know no other Octopod in which these ridges are so deeply flanged. When the latter are engaged, it seems to me that the intake of water must be entirely prevented, as the base of the funnel is so deep that there is no room for leakage at the sides. This condition is fore-

[1] Since writing this description, which is based on the preserved specimen, I have seen the original colour-sketch made when the animal was alive. The circular band of pale colour turns out to be a circumoral ring of eight round white patches, each of which lies astride an arm. Between this ring and the mouth, the web was bright reddish purple; peripherally and beyond the ring it was of an intense bluish purple. This pattern and coloration are extremely vivid and arresting.

shadowed in *Macrochlaena* (Robson, 1929, p. 194). The funnel itself is well developed. It is narrowly conical in shape, and its organ is well developed (Fig. 3). It consists of a thick-limbed plate in the shape of an inverted V (Λ). The fin supports (Fig. 2) are like none so far described. As in *Chunioteuthis ebersbachii* and *C. grimaldii* and *umbellata*, the

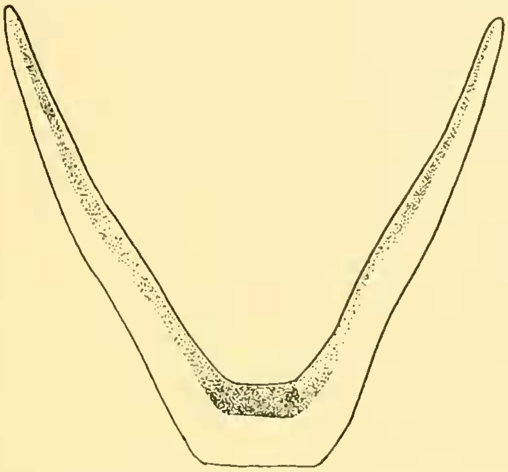


Fig. 2. *Cirroteuthis glacialis*. Fin support. × *c*. 2.

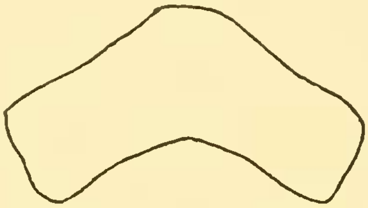


Fig. 3. *Cirroteuthis glacialis*. Funnel-organ. × 3.

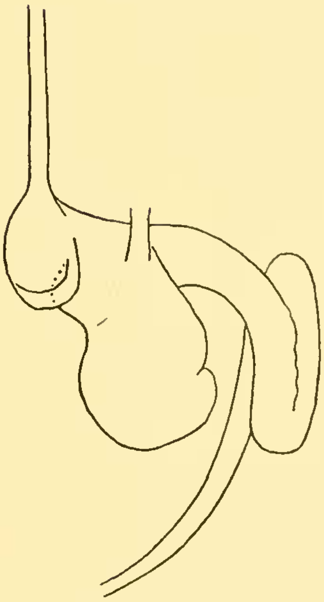


Fig. 4. *Cirroteuthis glacialis*. Alimentary canal. × 1·2.

Fig. 5. *Cirroteuthis glacialis*. Male reproductive organs. × 4.

"arms" of the supports are long. The apical part is angular (rather as in *C. meangensis*) and the whole structure is like a broad-based V.

Pallial cavity. The gills are prominent globular masses, as in *C. umbellata* (Ebersbach, 1915). They are relatively small (about $\frac{1}{5}$–$\frac{1}{6}$ of the pallial area) and consist of six main laminae, of which the most interior is reduced. I ought to point out here in connection with the general problem of adaptation that, though the gills are reduced in size, the laminae are much more folded, so that the surface of each filament is increased. The median adductor is very small, as in *C. umbellata* (Ebersbach, *l.c.*, fig. 3). On the other hand, owing to an excessive increase of connective tissue, the pallial cavity has become subdivided completely into two, a very unusual condition (cf. Robson, 1928, p. 261).

Alimentary canal (Fig. 4). The mandibles are present and, though somewhat soft, are normally developed. The palatal lamella of each is very small. The radula is absent. The anterior salivary glands are very small. There are no posterior salivary glands. The oesophagus is straight, and there is no crop. The lower end of the canal shows some peculiar features, which must be more fully discussed elsewhere. The stomach is equipped with a remarkably well-developed grinding apparatus. It contained a few fragments of Polychaeta. The caecum is much larger than the stomach, and may include part of the "third stomach" seen in *Opisthoteuthis* and *C. umbellata*. Its contents were so finely reduced that it was impossible to identify them. The intestine is bent on itself, as in *Opisthoteuthis*.

Reproductive organs (♂) (Fig. 5). There is no external trace of sexual differentiation, e.g. no abruptly enlarged suckers as in *S. albatrossi* and *Opisthoteuthis* (Sasaki, 1929, pp. 8, 11). The internal organs are like those of *C. umbellata* (Ebersbach, *loc. cit.*, Text-fig. 17) in general, but the proportions of the first accessory gland to the (conjoined) second and third is different.

REMARKS. This interesting form is like no described species. It seems to be most closely related to *C. megaptera* in external appearance. The internal organs are not unlike those of *C. umbellata*. The external appearance differentiates it at once from the other Antarctic species of Cirromorpha (*S. mawsoni*, Berry). It is a pity that Hoyle's Weddel Sea form (1912) was only fragmentary.

I hope shortly to publish a general discussion on this group. In the meantime, I must point out that the question of the adaptive significance of many of the peculiar features of these animals is rendered far more open than my recent account (1926) would lead one to suppose. In spite of the presence of some gelatinous tissue in *C. glacialis*, the arm- and fin-musculature is singularly powerful. The suckers are, if simpler in structure, more muscular than those of many Octopodinae, and are strangely assorted with the feeble mandibles and the absence of the radula. The gills, if small, have their small size compensated by the increased surface. The funnel and locking-apparatus are powerful; the adductor pallii medianus, as in *C. umbellata*, is feeble. This sketch will sufficiently indicate that we have to deal with an actively swimming and darting form with need for an ample supply of oxygen. Its diet seems to be that of a carnivore, but it is not easy to reconcile the lack of radula and the weakness of the jaws with the presence of powerful suckers, unless it be that it is a carrion eater and the suckers are used not for grasping prey, but in coition.

Sub-order *INCIRRATA*, Grimpe

Family ELEDONELLIDAE

Eledonella massyae, Robson, **subsp. purpurea**, subsp. nov.

St. 86. 24. vi. 26. 33° 25′ 00″ S, 6° 31′ 00″ E. 1000 (–0) m. 4½ m. tow net: one ♀.

Dimensions (in mm.).

		Arms, length:	L.	R.
Length of mantle (apex to eye)	53	1st pair	45	—
Mantle, width	35	2nd ,, ...	37 +	—
Head, width	18	3rd ,, ...	41 (? +)	—
		4th ,, ...	40	45

This form is related more closely to *E. massyae* (Robson, 1924, 1924 *a*) than to the other Atlantic or the Pacific forms.

It differs in the following particulars: (1) The suckers (which attain a maximum number of 10) are more widely spaced, viz. 6·5 mm. apart (as a maximum), instead of 4·5 mm. (2) The arms are a little shorter (54 instead of 56 per cent). (3) The funnel-organ (Fig. 6) is longer and more angular. (4) The radula differs in several particulars. In *massyae* the rhachidian bears three cusps on each side of the mesocone, the first lateral five cusps on an average. In the new variety there are two cusps aside on the rhachidian, and four cusps on an average on the first lateral. A still more striking difference is in the size of the mesocone of the rhachidian, which is $\frac{7}{10}$ of the base in the type of *massyae*. In the new variety it is $\frac{1}{2}$ of the base in length. (5) The gills are much smaller in the variety, being about 9 per cent of the mantle in length, while those of the type are about 16 per cent. (6) The colour is deeper and the chromatophores on the head tend to fuse up to a very dark purple hue.

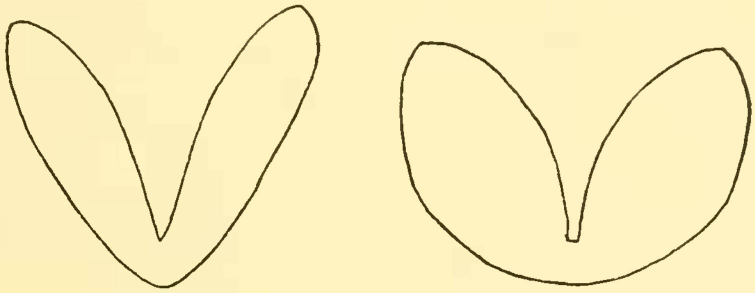


Fig. 6. *Eledonella massyae* (right) and *massyae*, var. *purpurea* (left). Funnel-organs. × 7.

This form is quite adequately distinguished from *E. pygmaea*, Verrill, by the spacing and number of suckers, the proportions of the arms and by the radula[1]; from *B. diaphana* by its characteristic funnel-organ and the number and spacing of the suckers; and from *E. heathii*, Berry, by the spacing and number of the suckers and the relative

[1] I assume that the radula figured by Thiele (1915, p. 491) is correctly referred to Verrill's species.

arm-length. In the remarkably low rhachidian mesocone it approaches *B. diaphana* (Thiele, 1915, fig. 60).

A very peculiar feature, which may be accidental, is seen in the surface tissues of the mantle. The epidermis is free from the underlying viscera, and encloses a spacious cavity in which the viscera and surrounding body-wall, by reason of their small size, are suspended free of the epidermis. I am unable to say if the absence of the subcutaneous gelatinous layer is natural, or caused by some accident of preservation. It seems to me that the latter is most unlikely.

REMARKS. I treat this form as a variety of *E. massyae* rather than as a distinct species, because on the whole the general facies is quite like that of *massyae*. The radula and funnel-organ certainly display marked differences. But for the time being I think the bulk of the resemblances is more important. As in the case of *Alloposus hardyi* (p. 397) we have to deal with a marked and peculiar character (in this case the absence of the subcuticular gelatinous layer), the precise morphological and systematic importance of which we cannot yet decide, as we do not know if it is not produced by accident.

Vitreledonella translucida, n.sp.

St. 273. 31. vii. 27. 9° 38′ 00″ S, 12° 42′ 30″ E. 200–230 (–0) m. Young-fish trawl: one ♂.

Dimensions (in mm.).

			L.	R.
Mantle, length (eyes to apex)	41	Arms, length:		
Mantle, width, % length	68 %	1st pair	45 ?	48
Head, width, % mantle-length	51 %	2nd „	46	44 ?
Web, maximum depth	14 (?)	3rd „	31 ?	37 ?
Suckers, maximum width	2·4	4th „	—	32
„ minimum width	1·0			

DESCRIPTION. The large and rather narrowly ovoid mantle is very unlike that of *V. richardi* (Joubin, 1924, pl. i), *alberti* (*id. loc. cit.* pl. ii) and *V. ingeborgae* (*id.* 1929 *b*, p. 18: fig. 40 seems to show a longer visceral sac than the text would suggest). The head, as in Joubin's species, is extraordinarily short. The eyes are small and prominent. Most of the arms have had their extremities damaged, but I am under the impression that they are in the order 1, 2, 3, 4. They are relatively very short, being about 54 per cent of the total length, as compared with 72 per cent in *V. ingeborgae* (240/330 mm.), 78 per cent in *richardi* and 71 per cent in *alberti* (the dimensions of Joubin's species being taken from the figures and therefore subject to a slight correction). The arms are thick and clumsy (though very transparent and delicate) over the greater part of their length, becoming rather rapidly thinner at the extremities. None of the apical suckers are preserved, except on the hectocotylised arm, so that I am very uncertain as to the total number. There are a maximum of twelve left on one arm, and I am inclined to believe that there were about eight smaller suckers beyond these, i.e. some twenty in all. On most of the arms there are seven to eight small and very widely spaced suckers, followed by about four much larger and more closely opposed ones. These (see above) were probably succeeded by about eight much smaller ones. The arrangement of the first part of the arm is not unlike that found in *V. ingeborgae*, but the extremity of the arm differs. As in *V. richardii* and *alberti* the suckers are planted in a gelatinous boss, which raises them well above the

Fig. 7. *Vitreledonella translucida.* Funnel-organ. × 6·2.

level of the arm. The enlarged suckers, however, are placed at the ordinary level. They are simple, thin walled, and show scarcely any structural differentiation. The web has been partly destroyed and I am unable to make out its exact form. I believe it attains a depth of

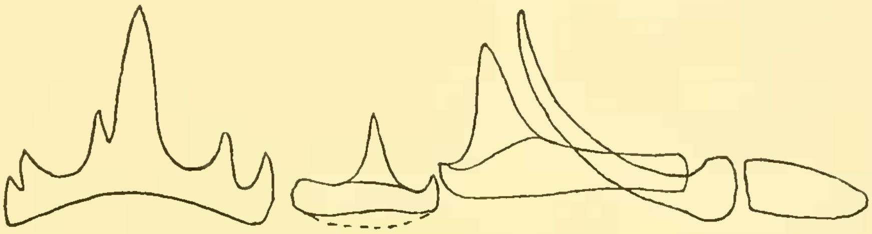


Fig. 8. *Vitreledonella translucida.* Radula.

about $\frac{1}{3}$ of the arm-length. The mantle-aperture is wide, the funnel short and stout. It contains a well-developed funnel-organ of the same general shape as that of *V. richardi*, but differing in sundry features (Fig. 7, and Joubin, 1924, pl. vi, fig. 5). There are seven filaments in the outer demibranch. The inner demibranch is absent as in *V. richardi*.

The radula (Fig. 8). Joubin's figure of *V. richardi* is not like that of *translucida*, except in general plan. The median tooth of *translucida* is markedly asymmetrical, and there is an *Octopus*-like seriation. The admedian has a large median mesocone, small ectocone and shallow base. The second lateral has an obvious inner "heel." The third laterals are long and slender and the marginal plates oblong. The radula is remarkably *Octopus*-like and very unlike that of *Eledonella* and its allies (*v.* anon).

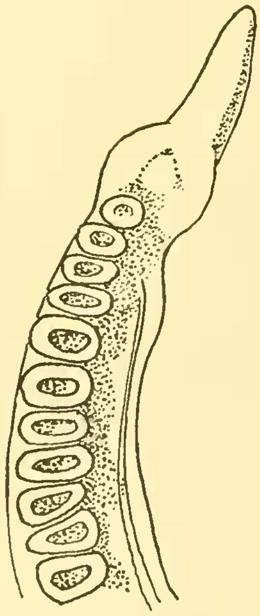


Fig. 9. *Vitreledonella translucida.* Hectocotylus (?). × *c.* 20.

The hectocotylus (?) (Fig. 9). The third arm of the *left* side has the appearance of being hectocotylised. The arm is shorter than its fellows, and on one side there is a narrow lateral membrane (absent from the other arms) like a seminal channel. There are a large number of closely appressed small suckers at the extremity (unlike the other arms). Shortly before the end they terminate in a faintly grooved excrescence, into which the presumed seminal channel also runs. The whole structure is not unlike that of *Amphitretus pelagicus* figured by Sasaki (1917, fig. 2). The likeness is heightened by the arrangement of the suckers and the absence of enlarged suckers on this arm. On the other hand, I could find no paired suckers (such as Sasaki figures) beyond the terminal swellings. The occurrence of this presumed hectocotylus on the left side and its resemblance to that of *Amphitretus* is very interesting.

REMARKS. The discovery of another species of this rare and remarkable form is an eminently satisfactory result. I propose to treat its structure as fully as possible in a forthcoming publication, and confine these remarks to the specific status of the Discovery specimen and one or two other points. *Vitreledonella* is represented at present by three species: *V. alberti* (Joubin, 1924, p. 38) was obtained at 33° 40′–52′ N, 19°–19° 16′ W in 0–3500 mm., and at 35° 09′ N, 21° 21′ W in 0–3500 m.; *V. richardi* (Joubin, 1918, p. 1; 1924, p. 15) was obtained at 30° 50′ N, 25° 43′ W in 5300 m.; *V. ingeborgae* (Joubin, 1929 *b*, p. 16) was taken by the 'Dana' at 36° 36′ N, 26° 14′ W in 2000 m. *V. translucida* is quite distinct from all these species. The principal differences are tabulated as shown on the opposite page.

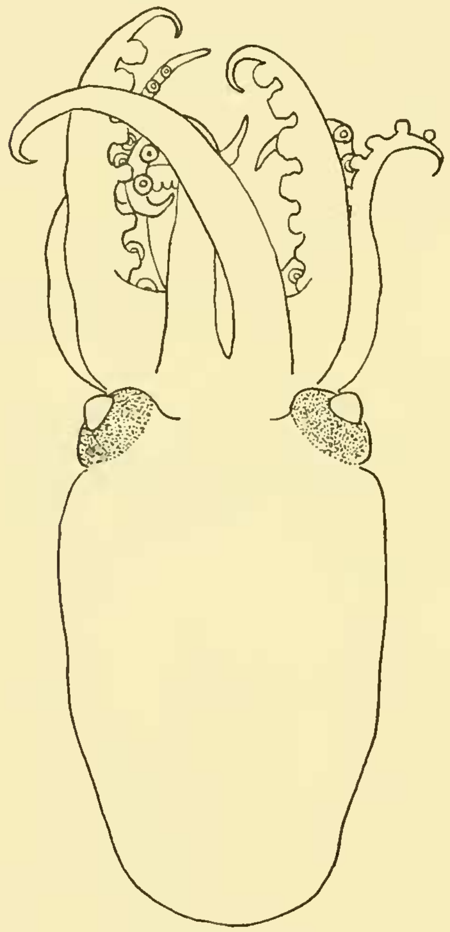


Fig. 10. *Vitreledonella translucida*. × 2. (Semi-diagrammatic.) See p. 380.

Joubin (1924, p. 16) was evidently of two minds as to whether these forms are pelagic or benthic. He admits that, though the net in which *V. richardi* was taken was lowered to a great depth (cf. *id.* 1929 *b*), it might have entered the net at an intermediate depth. The present record conclusively shows that it is a pelagic organism, though it may possibly have a very wide vertical range. Joubin (*loc. cit.* p. 18) makes the highly interesting observation that his *V. ingeborgae* is incubatory.

I shall discuss the affinities of this form more fully in a later publication. It is necessary, however, to point out the close resemblance of the radula to that of the Octopodidae and its divergence from that of *Eledonella* and *Amphitretus*, with which the genus is now ranked (Tribe Ctenoglossa).

	Mantle shape	Web depth	Suckers		Radula	Chromatophores	Length of gill
			Number	Arrangement			
1. *richardi*	Squat (47 × 47 mm.)	? $\frac{3}{10}$ arm length	30 (?)	12–14 (largest)	See below	Very rare on arms, more numerous on dorsal head and mantle	$\frac{10}{47}$
2. *ingeborgae*	Squat (30 × 30 mm.) (Joubin, 1929*b*, p. 18)	Nearly $\frac{1}{2}$ arm length (from fig.)	28	10 or 11–14 (largest)	Not described	Close and numerous everywhere, especially on dorsum	$\frac{8}{30?}$ *
3. *translucida*	Oblong (41 × 27 mm.)	Under $\frac{1}{3}$ arm length	12 large, probably 8 small	9–12 (largest)	Base of rhachidian shallower than in 1; entocone of first lateral much taller; ? shape of second lateral unlike 1, third lateral taller and more slender	Plentiful on arms and head: absent from mantle	$\frac{7}{41}$
4. *alberti*	Squat (41 × 41)	? $\frac{1}{5}$ arm length	22	6–9 (largest)	Not described	? absent	Smaller than in *V. richardi*

* The mantle length is that given on p. 18 of Joubin's paper (1929 *b*). Even if allowance is made for the lack of precision in defining the length, the measurement does not seem to agree with that indicated by Fig. 40 (p. 17).

Family AMPHITRETIDAE

Amphitretus thielei, n.sp. (Pl. III, fig. 2.)

? *Amphitretus pelagicus*, Hoyle, Thiele, 1915, p. 532.

St. 101. 15. x. 26. 33° 50′–34° 13′ S, 16° 04′–15° 49′ E. 350–400 (–0) m. 4½ m. tow net: one ♀.

Dimensions (in mm.).

	R.	L.
Mantle, length from eyes to apex	98	
Mantle, maximum width ...	52	
Head, width	24 ?	
Arms, length:		
1st pair ...	—	—
2nd ,, ...	180 × 82 +	—
3rd ,, ...	192 +	—
4th ,, ...	207 +	—

Web, depth in Sector		
A	95	Provisional
,, ,, ,, B	87	
,, ,, ,, C	106	
,, ,, ,, D	100	
,, ,, ,, E	90	

Description. The body has been somewhat distorted, and the gelatinous coat found in this genus removed (?) by the action of preservatives. The outer tissues are transparent, tough, and traversed by a network of thick fibres. The body is elongate-ovoid, the head very narrow and the eyes, as usual, closely set on the dorsal surface, and very prominent. The arms were probably subequal; but they are badly damaged. They attain a maximum of 67 per cent of the total length. The suckers are uniserial and widely spaced (about 14 mm. apart at the widest). The ends of the arms are damaged, but the suckers seem to have been alternating towards the tips. At about the thirteenth they become much larger. They are of a very simple structure and very thin walled. Except in *Melanoteuthis* I have never seen such an undifferentiated type. There must have been about forty (?) on each arm.

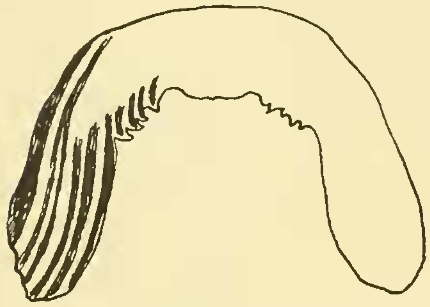


Fig. 11. *Amphitretus thielei.* Inferior mandible. (The pigmented streaks on one side have been omitted.)

The web is about half as deep as the arms and may have been subequal. The funnel is, as usual, adherent to the cephalic tissues, and extends well beyond the eyes. Its organ is large and broadly W-shaped. There is no trace of a valve.

The gills have seven to eight filaments in each demibranch. They are long and narrow and the inner demibranch is very much reduced, being but half as deep as the other. The mandibles are very weak and imperfectly chitinised. They are not so much splayed out as in Thiele's figure of *A. pelagicus*, and differ in many details, especially in the arrangement of the thickenings on the edge of the lower jaw (cf. Fig. 11 and Thiele, *loc. cit.*, fig. 65). The radula differs in many respects from that figured by Thiele, especially in the second and third laterals. The vaginae are remarkably thick and large. They are clearly demarcated from the small spermathecae.

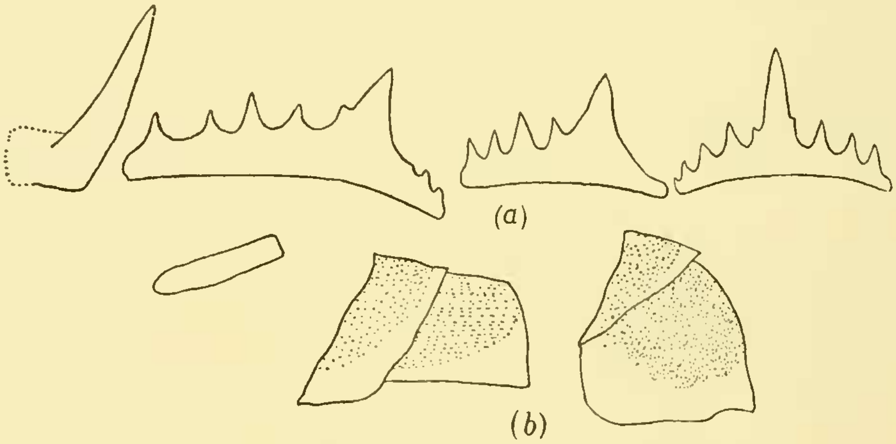


Fig. 12. *Amphitretus thielei.* (*a*) Radula, (*b*) Mandibles.

Remarks. The position of this form is very perplexing. So far a single species of this genus (*A. pelagicus*) has been observed. It was first described by Hoyle (1885, p. 235, 1886, p. 67) from a small specimen obtained off the Kermadec Islands. In 1902 Ijima and Ikeda (1902, p. 85) described a female obtained in 1897 in the Sagami Sea, Japan. Chun (1900, fig. on p. 535) and Thiele (*loc. cit.*) figured and described a third specimen from the Agulhas Stream (34° 31′ S, 26° 2′ E). Sasaki (1917, p. 361) described a male, also from the Sagami Sea. This and the other Japanese specimen were again described by Sasaki (1929, p. 16).

Now it is, to my mind, very uncertain whether all these descriptions relate to one and the same species. Sasaki had the advantage of seeing Ijima and Ikeda's specimen, and regarded it as conspecific with his own. But the relation of the Japanese, the South African and the Kermadec specimens is very uncertain. Hoyle's specimen is very small and in a poor condition, and Thiele only described the radula, mandibles (not known in the Japanese forms) and eye of the 'Valdivia' example, so that we are plainly not dealing with comparable data.

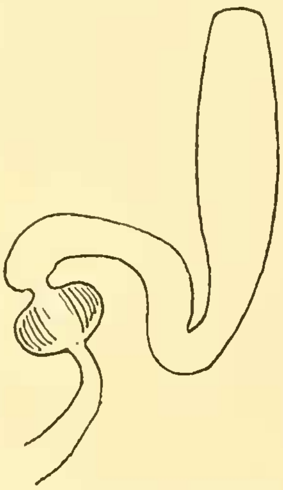


Fig. 13. *Amphitretus thielei.* Female gonaduct, etc. ×4.

Whatever we may think of these forms I am quite convinced that the specimen obtained by the 'Discovery' is not conspecific with any of the previously described forms. This is all the more striking, as it was obtained at no great distance from the spot at which the 'Valdivia' specimen was taken. It is very singular that two different species of this very rare genus should be taken more or less in the same area. However, it should be pointed out that the 'Discovery' specimen was taken to the west of Cape Town, i.e. in the Benguela Stream, and the 'Valdivia' one on the other side of the Agulhas divide.

The following table will make clear the differences:

	Total length	Arms (%)	Web (%)	Mantle width (%)	Suckers, no.	Gill filaments
thielei	305 mm.	67	51	53	? 40 +	7–8
pelagicus:						
Thiele	72 (?) (from fig.)	69 (?)	46 (fig.)	—	—	—
Hoyle (text and specimen)	45	66	75	122 (?)	23	—
Ijima and Ikeda	148	64	72	100	32–35	10
Sasaki (1917, 1929)	135	62	52 (?)	88	32	10

In addition, the radula and mandibles of *thielei* and the 'Valdivia' specimen are singularly unlike, and the funnel-organ of *thielei* agrees with that of neither the type of *pelagicus* nor of the Japanese forms.

Too much store need not be set on these characters, especially as only single specimens are involved. In the 'Valdivia' *pelagicus* the only useful systematic data we know are of the radula, jaws, general shape and web (as seen in the figure of Thiele, *loc. cit.* pl. xci, fig. 6). The web is more like that of *thielei*, about half as long as the arms, not two-thirds or three-quarters as long as in the type and Ijima and Ikeda's specimens of *pelagicus*. The latter and Sasaki's specimens seem to differ quite markedly from *thielei*. It thus seems that *thielei* is quite distinct from the type and other specimens of *pelagicus*, though in one character it is not unlike Thiele's *pelagicus*. The status of the latter is very uncertain. In the light of this evidence it is quite impossible to do otherwise than treat *A. thielei* as a distinct species.

Concerning the general affinities and status of these forms, I need say very little at present. They plainly present us with a problem of the greatest interest. In the first place, the external "choroidal" gelatinous coating, double pallial aperture, multicuspid teeth and telescopic eyes suggest high specialisation. The remarkably developed teeth, however, seem to accord little with the very weak jaws (the reverse situation in fact to that in the Cirromorpha) and simple suckers. The suckers, teeth, vaginae (?) and gills suggest relationship with the Eledonellidae. The funnel-organ is, however, *Octopus*-like.

Family OCTOPODIDAE

Sub-family *ELEDONINAE*

Forty-four specimens were obtained by the 'Discovery,' all of which were in very good condition. This rich haul, which far surpasses any series obtained previously, provides us with an admirable opportunity of reviewing this characteristic Antarctic group.

In a work, shortly to be published, I hope to discuss in full the systematic relationship of all the forms that have been placed in *Eledone* and the status of the sub-family. I am of the opinion that Naef was correct in his suggestion that the genus may be polyphyletic (1923, p. 716). A final verdict on this subject is not at the moment possible. I content myself with pointing out the following facts:

(1) The Antarctic species so far described differ very markedly from the Mediterranean forms, and certainly do not belong to the same genus. I consider that the name *Eledone* should be kept for *E. moschata* and *cirrosa* and that *charcoti*, Joubin (*aurorae*, Berry *syn.*), *turqueti*, Joubin, *antarctica*, Thiele, *harrissoni* and *adelieana*, Berry, and *polymorpha* (p. 390) should all be placed in *Graneledone*, Joubin. The status of Berry's *albida* is not for the moment clear, though I believe it should be placed with *E. rotunda*, Hoyle, in a distinct genus or sub-genus. *T. gunteri* (p. 392) is placed in a different genus, principally on account of its highly degenerate radula.

(2) The new species now described bring up the number of Eledonid species to sixteen (irrespective of doubtful forms), if we accept Berry's suggestion (1918) that his *aurorae* is identical with *charcoti* and keep *media*, Joubin, as a distinct species (cf. Joubin, 1924, p. 38). Of these nine are from Antarctic or sub-Antarctic waters, three more are from southern waters. The remaining four are from the north Atlantic. The group is very largely absent from tropical waters, and is poorly represented in the Indo-Pacific region. Its metropolis and probable place of origin is the littoral of the Antarctic continent and deeper water further north, with a smaller offshoot in the north Atlantic and Mediterranean.

The identification of the various forms represented in this collection, and their relationship to previously described species, have proved a very difficult matter. They do not readily fall into line with the specific distinctions proposed by other workers, nor am I satisfied that those distinctions represent natural groups. The initial difficulties towards a clear understanding of the Antarctic Eledones will become clear, if the following facts are borne in mind.

(1) In general the parts usually described in systematic papers are very variable and, unless a large number of individuals is available from which a clear statistical expression can be obtained, descriptions such as "web deep," "arms short," etc., are valueless.

(2) The character of the hectocotylus is a valuable feature.

(3) The epidermal sculpture is very liable to be effaced and is subject to modification by the contraction of the skin.

(4) Though very little is known on the subject, it is plain that the proportions of arms, web and eyes alter during development, so that the young stages differ materially from the adults.

Now the descriptions of previously known forms of *Eledone* from this area are difficult to utilise, either because they are based on a single or a few specimens, or because the latter are small, or because females only were available, or finally because they were based on characters of very dubious value.

The species in question are as follows: *E. charcoti*. The type is a rather small female specimen. Joubin subsequently figured (without description) two smaller examples (1914). Massy (1916) described in some detail the anatomy of this form from fifteen adults and five young. She did not, however, describe the variation in the external diagnostic features. Hoyle (1912) described the colour, hectocotylus and radula, using two specimens from the South Orkneys, but without giving other external diagnostic characters. In 1917 Berry described a single male from off Queen Mary Land under the name of "*Moschites aurorae*." Odhner (1923) recorded some examples from South Georgia without full description. The same incompleteness rules in our knowledge of *E. turqueti*. This was originally described from Wandel Island off Danco Land by Joubin (1906) from a single small female specimen measuring 42 mm. over all, and in 1914 he cited (with a few notes and two figures) three small specimens and one much larger example from King George Island, South Shetlands. In 1916 Massy described the anatomy of four specimens (three females, one male) from Rio de Janeiro and McMurdo Sound, Ross Sea.

Turning now to the Antarctic species described by Berry (1917), we find that *M. albida* (Wilkes Land) is known from one female, *adelieana* is represented by a single adult female and two young and *harrissoni* by three females and one other specimen.

From these remarks it will be seen at once that the available descriptions are either based on very small series, or are of uncertain application. The determination of the specimens obtained by the 'Discovery' is therefore of no little difficulty.

In the forty-four specimens available I find that four distinct forms can be recognised:

(1) A broad-bodied form with rather a narrow head and small eyes. The web varies

from 22–42 per cent: the funnel-organ is double, its components are thick and short. The hectocotylus is 8–11 per cent of the third arm. The sculpture is never as close and as well developed as that of *E. charcoti*, though it is of the same type. I regard this form as conspecific with *E. charcoti*.

(2) A broad-bodied, narrow-headed form with exceptionally short arms (57 per cent) and very deep web (60 per cent). The funnel-organ is double. The gill-filaments are exceptionally low (five to six) in number. The eyes are large, but not adnate. The sculpture is highly characteristic, being composed of flattish irregular, very clear-cut, tubercles, rather like those of *O. pallidus*. It has no ink sac and the radula is degenerate. It is so distinctive that I must treat it not only as a new species, but as referable to a new genus (p. 392).

(3) A narrower, smooth or obscurely granular form, with very large eyes. The head is not much narrower than the body. The hectocotylus is rather small (6–8). The funnel-organ is double. This I regard as Joubin's *E. turqueti*, though the original specimen of the latter was very small and, at the same time, unlike those figured subsequently by Joubin. I rely on the later figures for my identification.

(4) More uncertainty invests the fourth form, which seems to occur in two phases, one of which seems to be related to certain forms of *E. charcoti*. I provisionally treat this as a distinct species (*E. polymorpha*). The skin is granular, the eyes moderate to large, the funnel-organ is single and the hectocotylus large (17–9 per cent). It appears in two phases: (*a*) a narrow form with the head as wide as the body and a deep web, and (*b*) a more obese form with a shallower web. This form has a marked tendency to bear a peripheral keel. In other respects it is not unlike *E. charcoti*.

I have carefully considered the relationship of the new species with those given in Berry's key (1917, p. 14), and can find no likeness to any in the latter. *E. polymorpha* has certain features in common with Berry's *E. harrissoni*. This matter is discussed on p. 392 and the possibility that these forms may be conspecific is set aside as most unlikely.

Consideration of the structure of the radula, hectocotylus and other organs leads me to believe that this genus should be sub-divided into several sub-genera to render apparent certain marked structural divergences. Some of these have been already proposed, but I defer to a later publication the complete rearrangement of the group. For a preliminary discussion and remarks on the interesting new genus, *Thaumeledone*, see pp. 374, 392.

Genus **Graneledone**, Joubin

Graneledone charcoti, Joubin.

Eledone Charcoti, Joubin (1905, p. 22).

Thirteen examples (five ♂♂, eight ♀♀) from South Georgia and vicinity.

St. 39. 25. iii. 26. East Cumberland Bay, South Georgia. 179–235 m., grey mud. Large otter trawl: three ♀♀ (Brit. Mus. 10 (i–iii)).

St. 42. 1. iv. 26. Mouth of Cumberland Bay, South Georgia. 120–204 m., mud. Large otter trawl: one ♂ (Brit. Mus. 12).

St. 45. 6. iv. 26. 2·7 miles S 85 E of Jason Light, South Georgia. 238–270 m., grey mud. Large otter trawl: one ♀ (Brit. Mus. 3). Three ♂♂ (Brit. Mus. 13).

St. 123. 15. xii. 26. Mouth of Cumberland Bay, South Georgia. 230–250 m., grey mud. Large otter trawl: one ♀ (Brit. Mus. 7).

St. 140. 23. xii. 26. Stromness Harbour to Larsen Point, South Georgia. 122–136 m., grey mud and stones. Large otter trawl: one ♀ (Brit. Mus. 15).

St. 154. 18. i. 27. Jason Harbour to Larsen Point, South Georgia. 60–160 m., mud. Large otter trawl: one ♀ (Brit. Mus. 6).

St. WS 25. 7. xii. 26. Undine Harbour (North), South Georgia. 18–27 m., mud and sand. Small beam trawl: one ♂ (Brit. Mus. 16).

St. WS 32. 21. xii. 26. Mouth of Drygalski Fjord, South Georgia. 225 m., grey mud. Small beam trawl: one ♀ (Brit. Mus. 8).

The body is usually plump and the head narrow, the mantle index averaging 116–93, that of the head 84–60. The average form of the head and body is thus very like that figured by Joubin. The arms are short, 72–76 per cent of the total length. The suckers do not vary in diameter as between males and females (range 12–8·3 per cent). The web is 42–22 per cent of the arms. E tends to be larger than A, and C is the deepest. There is usually a trace of a lateral keel. The sculpture is very variable. It should be noted here that Joubin's earlier description dealt with a heavy sculpture of closely apposed boss-like tubercles. His later description was of a more granular sculpture (cf. 1914 [?], fig. 1). In the material before me I find a similar variation which may be tabulated as follows:

Brit. Mus. 3: rather isolated warts, nearly obsolete apically; warts present on inner side of arms; ? ocular cirrhi.

Brit. Mus. 12: large (not close) and granular warts; ocular cirrhi absent.

Brit. Mus. 7: warts ? originally well developed, though widely spaced, now very much worn; ocular cirrhi present.

Brit. Mus. 8: warts very small; ocular cirrhi.

Brit. Mus. 15 = 3: ocular cirrhi present.

Brit. Mus. 16: warts granular; ocular cirrhi.

Brit. Mus. 13 = 3: but warts sparser; ocular cirrhi.

Brit. Mus. 10: (two specimens too much wrinkled to examine). Small close warts; ocular cirrhi present.

The specimens from the 'Terra Nova' collection are more regularly warty and less granular than the Discovery ones, and I think are nearer Joubin's heavily sculptured form.

The funnel-organ is VV-shaped and, as indicated by Massy, the limbs are coarse and thick, though they are not always so coarse as is seen in her figure. There are eight to eleven filaments in each demibranch. The hectocotylus is 8–11 per cent of the arms. The calamus is well developed and acute, the ligula usually well excavated, with thick sides. A number of rather feeble laminae are present. The hectocotylus, it should be noted, is far more like that of *Octopus* than are those of the European forms, which lack a calamus. I suggest that the Antarctic forms are more archaic in this respect. The penis in two specimens (10) was short and coarse, and bears a large saccular diverticle containing an enormous spermatophore, about 82 mm. long, and very thick (cf. Massy, 1916, p. 153).

Graneledone turqueti, Joubin.

Eledone Turqueti, Joubin (1905, p. 29).

St. 158. 21. i. 27. 53° 48′ 30″ S, 35° 57′ 00″ W. 401–411 m., rock. Large dredge: three young specimens (♂ 1, ♀ 1, ? sex 1) (Brit. Mus. 4 *a*).

St. 181. 12. iii. 27. Schollaert Channel, Palmer Archipelago. 160–335 m., mud. Large otter trawl: three adult specimens (2 ♂♂, 1 ♀, two inv.) (Brit. Mus. 4). (?)

The body is saccular, and the head but little narrower than the mantle. The arms are very short (72–64) and the suckers small (11·5–7·4). The biserial arrangement of the suckers on the fourth arms, noted by Joubin in his first description, is found in one Discovery specimen; but this feature is not of diagnostic value. The web is markedly bilateral, C and D being much deeper than A and E. The web is shallow. In the Discovery specimens it is 20–25 per cent of the arms. In one 'Terra Nova' example it reaches 27 per cent. The head is broad, and the eyes very large. The skin is either quite smooth, or else here and there it shows traces of fine granulations. It is of a more or less uniform light purple colour.

The mantle aperture is very narrow. The funnel-organ is VV-shaped; in the larger specimens its limbs seem to be almost as thick as those of *charcoti*. There are ten to eleven filaments in each demibranch. The hectocotylus is small, about 6 per cent of the hectocotylised arm, that of the only 'Terra Nova' male being 7 per cent. Unfortunately, this organ is fully developed in none of the Discovery males. In the largest it looks as though it might ultimately grow to resemble that of *charcoti*. The penis has a large bent receptaculum, as in *charcoti* (above).

REMARKS. Joubin's species was, as already pointed out, based on small examples.

Graneledone polymorpha, n.sp. (Pl. III, fig. 1.)

St. 39. 25. iii. 26. East Cumberland Bay, South Georgia. 179–235 m., grey mud. Large otter trawl: one ♂ (Brit. Mus. 10 (iv)).

St. 42. 1. iv. 26. Mouth of Cumberland Bay, South Georgia. 120–204 m., mud. Large otter trawl: seven specimens (3 ♂♂, 4 ♀♀) (Brit. Mus. 12).

St. 45. 6. iv. 26. 2·7 miles S 85° E of Jason Light, South Georgia. 238–270 m., green mud. Large otter trawl: one ♀ (Brit. Mus. 13 (iv)).

St. 142. 30. xii. 26. East Cumberland Bay, South Georgia. 88–273 m., mud. Large otter trawl: six specimens (1 ♂, 5 ♀♀) (Brit. Mus. 1).

St. 148. 9. i. 27. Off Cape Saunders, South Georgia. 132–148 m., grey mud and stones. Large otter trawl: two ♀♀ (Brit. Mus. 9).

St. WS 62. 19. i. 27. Wilson Harbour, South Georgia. 15–45 m. Small beam trawl: four specimens (2 ♂♂, 2 ♀♀) (Brit. Mus. 14). (?)

St. MS 63. 24. ii. 25. East Cumberland Bay, South Georgia. 23 m. Small beam trawl: one ♂ (Brit. Mus. 11). (?)

St. MS 68. 2. iii. 25. East Cumberland Bay, South Georgia. 220–247 m. Large rectangular net: two specimens (1 ♂, 1 ♀) (Brit. Mus. 5).

DESCRIPTION. This form occurs in two phases, the external features of which are described separately here.

(1) Form *oblonga* (13 (iv), 10 (iv), 5 (i)). The mantle is narrow (80–64) and the head but little narrower (69–61). The arms are 73–67 per cent of the total length. The suckers are very small, 7–8 per cent. The web is deep, 38–34 per cent. The proportions of the sectors vary. The eyes are rather large. There are seven to eight filaments in each demibranch. The funnel-organ is W-shaped. The surface is covered with rather widely spaced, small granules. In 5 (i) these are larger than in the other two, and might pass as small warts. 5 (i) is rather different from the other two, not only in sculpture but also in its web (which is longer than in the other two examples and is in addition equal in all its sectors save E) and in its wider body. The hectocotylus of 5 (i) and 10 (iv) are, however, both long (15 and 13·9 per cent respectively) and very alike. The calamus is acute and upstanding, the ligula rather shallower than in *charcoti* and crossed by a number of deep laminae, which resemble those of a *Bathypolypus*.

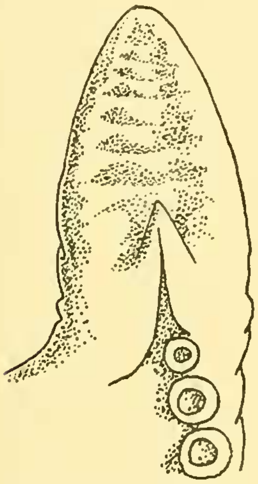


Fig. 14. *Graneledone polymorpha*. Hectocotylus. × 3.

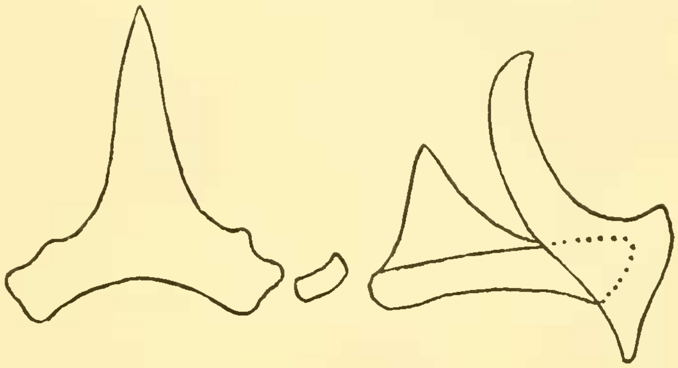


Fig. 15. *Graneledone polymorpha*. Radula.

(2) Form *affinis* (1, 9, 11, 12, 14). The body is rather wide, its index being 104–70. The head is usually much narrower, 93–53 per cent, the most usual form being that with a globular body and small, clearly defined head. The arms are about as long as the form *oblonga*, viz. 74–66. The suckers range from 11·6–7 per cent. The web is distinctly shallower (30–27 per cent) and tends to be rather regularly bilateral. The eyes are moderate to large. The sculpture, as in *oblonga*, varies from fine, rather widely spaced granules to granular warts. The funnel-organ is W-shaped. There are seven to ten filaments in each demibranch. The hectocotylus (Fig. 14) varies from 17 to 9 per cent (? 7 per cent) of the arm in length. The forms of the ligula and calamus are very like those in var. *oblonga*, though the copulatory groove is narrower, and its walls correspondingly thicker. This condition is best seen in the male from Station 42. In the other males the organ is more like that of *E. charcoti*.

In both forms the dorsal surface is demarcated from the ventral. In practically every example there is a well-marked ridge, in some specimens amounting to a thick keel (e.g.

in some from Station 142). This ridge or keel is absent in the specimen from Station MS 63. The radula (Fig. 15) has a rhachidian with a long stout mesocone, the height of which exceeds the base. There are, on some teeth, faint traces of entocones; but the tooth is to be regarded as unicuspid. The admedian is small, narrow and has a low, blunt entocone. The second lateral has a rather narrow and shallow base with a low, heavy subterminal cusp. The third laterals are small, much curved and have wide bases.

The colour in all these specimens varies from dull olivaceous purple to brown.

REMARKS. I am far from certain as to the status of all the forms which I have placed in this species. Perhaps the issue will be narrowed a little, if we realise that, of all the previously described species, its closest relationships are with *E. charcoti*. It clearly has no connection with the smooth Antarctic forms *adelieana* and *albida*, from both of which it differs in many characters.

Similarly it is very unlike *turqueti*. The squatter phase has some likeness to *E. harrissoni* and, indeed, from the key given by Berry (*loc. cit.* p. 14) one might think that the two forms would prove to be identical, except for the difference in the form of the funnel-organ. Moreover, the "dull clouded slaty grey" colour, alluded to by Berry, is very often found in *polymorpha*. On the other hand, the form of the funnel-organ and radula, the shape of the eyes, head and body and the greater depth of sector A of the web (20–23 per cent in *harrissoni*, 30–27 per cent in *polymorpha*) are all characters which make it impossible to identify the two forms.

There remains *E. charcoti*, and with that form the resemblance is nearer. As far as the bodily proportions, arms, suckers and gills are concerned, the two species do not differ in any material respect, except of course in so far as the form *oblonga* is much narrower. The web of the latter, but not of form *affinis*, is as deep as that of *charcoti*. The sculpture in the more extreme forms (e.g. the type) of *charcoti* is, of course, very distinctive; but there are specimens in which it is more granular and like that of *polymorpha*. The following characters, which seem to be regularly associated, are, to my mind, good differentia: the form of the funnel-organ, hectocotylus and radula, and the regular presence of a prominent and well-developed keel (either absent or seen merely as a poorly developed ridge in *charcoti*). It must be borne in mind that, in the array before us, there are a certain number of individuals which exhibit various combinations of the characters of the two species, and may be hybrids. The species are to be recognised on account of the higher frequency of certain character-associations.

Genus Thaumeledone, n.gen.

The radula is very degenerate, being reduced to little more than the rhachidian teeth. There is no ink sac. The funnel-organ is double. The gills are very much reduced. Type of the genus: *Eledone brevis*, Hoyle.

Thaumeledone gunteri, n.sp. (Pl. IV, fig. 3.)

St. 158. 21. i. 27. 53° 48′ 30″ S, 35° 57′ 06″ W. 401–411 m., rock. Large dredge: one ♀ (Brit. Mus. 2) [Type].

Dimensions (in mm.).

Dorsal mantle, length	36
Head, width, % mantle length ...	86
Mantle, width, % mantle length ...	111
Arms, % total length	57
Suckers, diameter, % mantle length	8·3
Web, index	60

The body is globular, and the head distinctly narrower than the body. It is, however, rather broader than is usual in *charcoti*. The eyes are distinctly larger than in most examples of the latter. The arms (see above) are very short for an adult Octopod, being amongst the shortest recorded. The suckers are small and close set. The sectors of the web are, I think, subequal, C and D being slightly deeper than the others. The web is very large, and attains the great depth of 60 per cent of the arms. The surface is rather a rich, light purple dorsally, becoming paler ventrally. It is covered dorsally and laterally by a number of close-set warts. These are very curious, and confer on the animal a rather mossy appearance. On the sides of the web and on the arms they tend to be circular and bubble-like. On the anterior surface of the web, head and body, they are branched and irregular, and it is here that they are seen to stand out very clean-cut from the surface. They remind me of the similarly clean-cut warts in *Octopus pallida*, though they are not stellate in *gunteri*. It is possible that they may be like those of a form of *charcoti*. Joubin (1906, p. 6) says that in the latter some of the warts were probably branched. From the figure (*loc. cit.* pl. i, figs. 1–2) it is quite evident that, in *charcoti*, the warts on the head and body are in contact with each other, while in *gunteri* they are quite separate. In Joubin's later figure (1914[?], p. 36) and in one of the 'Terra Nova' specimens the warts are quite separate but, in the former, they are granular, and in the latter, they are mammiform, both very unlike those in *gunteri*.

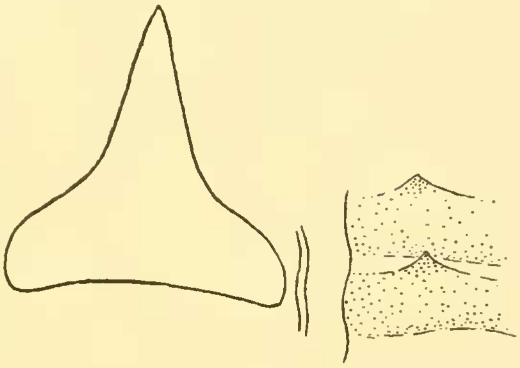


Fig. 16. *Thaumeledone gunteri.* Radula. (The remains of the degenerate second laterals are shown dotted.)

The funnel is short, narrow and pointed. The funnel-organ is VV-shaped. The limbs are rather slender and pointed at each end. They remind one of those of *E.* "*aurorae*" (Berry, 1917, fig. 14). There are five to six filaments in each demibranch, a very low number. The ink sac is absent. The radula is degenerate and represented by a simple unicuspid rhachidian, the mesocone of which is low and stout. There are faint traces of admedian teeth and of an oblong second lateral with a low cusp.

Remarks. This species has a superficial resemblance to *E. charcoti*. For a long time I considered that it should be treated as a well-marked sub-species of the latter, especially since only a single specimen is available, and that a female. The profound differences in radula, etc., were then discovered. The degeneration of the radula and loss of the ink sac, length of the arms, depth of the web, number of gill filaments, the sculpture and, in a less degree, the shape of the funnel-organ components and head, form a highly peculiar and characteristic assemblage.

Upon examination of other species of *Eledone* from adjacent seas I find that *E. brevis*, Hoyle (1886), has a degenerate radula of the same type as *gunteri*. It is also devoid of an ink sac. Though quite distinct specifically, I consider that these two interesting forms are congeneric.

Sub-family *BATHYPOLYPODINAE*

Benthoctopus sp. (? januarii var.). (Pl. IV, fig. 2.)

St. WS 86. 3. iv. 27. 53° 53′ 30″ S, 60° 34′ 30″ W. 151–147 m., sand, shells and stones. Commercial otter trawl: five specimens (3 ♂♂, 2 ♀♀).

Dimensions (*in mm.*).

	Mantle length	Width % Length	Head, width, % mantle length	Arms (index)	Suckers (index)	Gills	Web (index)	Ligula (index)
1. ♀	92	88	66	79	7·6	—	21	—
2. ♂	73	76	65	79	6·7	10	25	6·6
3. ♂	64	82	71	79	?	10	29	5·6
4. ♂	43	100	100	75	8·1	—	30	3·1
5. ♀	43	88	88	77	8·1	10	36	—

It will be seen from these figures that the five specimens are by no means alike. I think, however, that the differences between the two larger and the two smaller are mainly referable to age. All five specimens have unmistakably the same general facies, though the smaller are admittedly squatter and broader headed. In addition to the features indicated above the following points must be noted. The skin is entirely smooth, and there are no cirrhi of any sort. The funnel-organ is W-shaped. It is better preserved in the younger specimens, and in them it is rather widely spread and thin limbed. In the older specimens it seems thicker and narrower, though of this I am not quite certain, as the organ is not well preserved in them. The gill is remarkably deep, the longest filament measuring 18 mm. in the largest specimen. The inner demibranch is little reduced. There is no ink sac in any of the specimens. The radula is not unlike that of *B. januarii*, at least in so far as its admedian and first lateral teeth are concerned. The rhachidian has the same general type of seriation in both species, but differs in sundry details. The third laterals are more slender in the Burdwood Bank forms.

The *hectocotylised arm* is 56–69 per cent of the longest arm. The ligula is short and pointed, and in no. 2 (the best developed) the copulatory groove is deep and narrow, the sides thick and traversed by transverse grooves. The calamus is well developed and reaches about a third of the way along the organ.

The internal male organs. Needham's organ has a moderate head and slender extremity. There is but a feebly indicated appendix. The penis has a moderate diverticle. There are numerous thread-like spermatophores, about 45–47 mm. long, with very slightly swollen heads. They are of a peculiar milky white colour. The spermatophores of *B. januarii* are much thicker and have swollen heads.

The *colour* in all the specimens is a pale fawn-pink.

REMARKS. This very interesting form has given me a good deal of trouble, and I am still undecided as to whether it is a distinct species or a form of one of the South American or sub-Antarctic species. It seems to have distinct affinities with *B. januarii* (*s.s.*) and *B. magellanicus* (Robson, 1930*a*, p. 332), and some likeness to *B. eureka*. For the time being, and until the work I have on hand upon the genus is completed, I think it better to give this a non-committal description. The following list exhibits the differences from the more closely related forms:

(1) It differs from *B. januarii* in (*a*) arm-length, (*b*) web depth, (*c*) form and size of hectocotylus, (*d*) size of gills, (*e*) spermatophores. The general facies (smooth rounded body and large eyes, and radula) are points in common.

(2) It differs from *B. magellanicus* in (*a*) funnel-organ, (*b*) colour, (*c*) hectocotylus. The sculpture (if any) of *B. magellanicus* is not properly known.

(3) It differs from *B. eureka* in (*a*) form of penis, (*b*) appendix, (*c*) radula, (*d*) colour.

I should point out that the other members of the Octopodidae reported from Magellanic waters are either referable to *Joubinia* or *Enteroctopus* and cannot be identified with this form for many reasons. Hoyle's "*Polypus brucei*" from the Burdwood Bank (1912) is a form of Gould's *E. megalocyathus* with which also Lönnberg's *O. patagonicus* is synonymous.

Benthoctopus magellanicus, Robson.

St. WS 97. 18. iv. 27. 49° 00′ 30″ S, 61° 58′ 00″ W. 146–145 m., sand, gravel and stones. Commercial otter trawl: one ♀.

This species was distinguished by me (1930*a*, p. 332) from *B. eureka* by certain features that still seem to me important. It is a little unfortunate that the female of the nearly-allied *B. eureka* is unknown, and also that there is as yet no comparable material of the funnel-organ which, in the Paris specimen (♀) originally labelled "*O hyadesi*" (see Robson, *l.c.*, p. 330), is so characteristic.

The following table and data will show that this specimen, which measures 385 mm. over all, is probably more like *B. magellanicus*:

	(1) Discovery WS 97 (♀)	(2) *magellanicus* (♀ ♂) (Robson, 1930*a*)	(3) *eureka* (♂) (Robson, 1929)
Arm-length (% total length)	77	78–74	79–81
Suckers, diameter (index) ...	13	10–9	12
Web, depth (index)... ...	32	32–31	23–28
Colour	Reticulate, purple on a light ground	= no. 1	Dark purple with a few patches of pink on dorsum

In addition, the Discovery specimen has long, narrow and crescentic eggs (21 × 5·5 mm.) exactly like those of *magellanicus*. The size and shape of the oviduct is exactly alike in the two forms, and the relative proportions of oviduct and vagina are alike. The form of the funnel-organ is uncertain.

While admitting the very remote possibility that *magellanicus* is a form of *eureka*, I believe that the Discovery specimen is more like the former than the latter (except in the diameter of the suckers). We have no female of *eureka* for comparison, but it is worth pointing out that, though the Discovery specimen and the type female and male of *magellanicus* are very alike, the latter differs from the *eureka* (male) in the hectocotylus.

Sub-family *OCTOPODINAE*

Octopus (Enteroctopus) megalocyathus, Gould.

St. 222. 23. iv. 27. St Martin's Cove, Hermite Island, Cape Horn. 30–35 m. Large rectangular net: one ♀.

Dimensions (*in mm.*).

	R.	L.
Mantle, length, eyes to apex		44
,, width, % length		81
Head, width, % mantle length		68
Arms, length:	R.	L.
1st pair	136	137
2nd ,, ...	132	136
3rd ,, ...	—	118
4th ,, ...	126	120
Arms, % total length	75	

Suckers, maximum diameter (as % mantle length)	18
Web, depth, in sector A	37
,, ,, ,, B	39
,, ,, ,, C	39
,, ,, ,, D	38
,, ,, ,, E	29
Web, % longest arm	30

While admitting that the correct names and the identity of the Magellanic Octopodinae are still uncertain, I do not feel much hesitation in referring this specimen to the broad form of Gould's species as re-defined by myself (1929). The very characteristic funnel-organ, like a flattened W (cf. Robson, 1929 *a*, p. 617, and 1930, p. 240), wide suckers, smooth skin, light brown colour, the number of branchial filaments (eleven in each demibranch), the form of the web (A, B, C, and D subequal, and E more or less markedly shorter), all remind one strongly of certain forms of *megalocyathus*. The arms are rather shorter, and the web is certainly deeper than in the average *megalocyathus*. The ink sac is present. The oviducts, etc., and ovary are in a very undeveloped (? atrophied) condition.

Octopus (Octopus) rugosus (Bosc).

St. WS 237. 7. vii. 28. 46° 00′ S, 60° 05′ W. 150–256 m., coarse brown sand, shell fragments. 7 mm. mesh net on trawl: one ♀.

Simon's Town. 29. vi. 27. Found while draining the dock: one ♀.

The specimen from near the Falklands is typical in respect of its colour and reticulate pattern, squat body, rather broad head, shortish arms and web-form. The skin is closely and tightly wrinkled, and it is impossible to say if the typical shagreen of rough warts is present. In any case, however, I think that it is smoother than is usual and in parts may be entirely smooth. It is otherwise so characteristic that I do not hesitate to identify it with Bosc's species. Sector A, though shallower than E, is not noticeably shallower (as is usually found in *O. rugosus*).

The specimen from Simon's Town is a typical form with well-developed sculpture of neat, close multifid warts. The colour is rather dark, but the characteristic reticulate pattern is well seen.

Octopus (Octopus) vulgaris, Lam.

Simon's Town. 29. vi. 27. Found while draining the dock: one ♀.

A very large specimen with typical sculpture, about 120 mm. long in dorsal mantle length. The arms are so much contracted that I cannot satisfactorily ascertain their length and that of the web. The suckers, as in some old females of this and other species, are very wide, the index (see p. 374) amounting to 15–16. It is a pity that it is not possible to study this specimen in greater detail, as it is desirable to check carefully all identifications of this species in tropical and southern latitudes.

Family ARGONAUTIDAE

Sub-family *ALLOPOSINAE*

Alloposus hardyi, n.sp. (Pl. IV, fig. 1.)

St. 288. 21. viii. 27. 00° 56′ 00″ S, 14° 08′ 30″ W. 250 (–0) m. Young-fish trawl: one ♂.

Dimensions (in mm.).

Mantle, length, eyes to apex		40	Web, depth, in sector A	50
,, width		35	,, ,, ,, B	43
Head, width		38	,, ,, ,, C	36
Arms, length:	R.	L.	,, ,, ,, D	24 ?
1st pair	?	112	,, ,, ,, E	18 ?
2nd ,, ...	83	87 ?		
3rd ,, ...	?	?		
4th ,, ...	60	50		

The body seems to be broadly ovoid. Its width is only a little less than its length. It decreases in width from the level of the base of the arms towards the apex. On the left side there is a low keel. The general shape recalls that of the short, broad form of *Bathypolypus arcticus*. The eyes are large and prominent. The arms are 73 per cent of the total length and are, as usual in the group, in the order 1, 2, 3 (?), 4, the last arm being about half the first in length. The web is in the order A, B, C, D, E, E being nearly $\frac{1}{3}$ the depth of A. The tissues are almost entirely gelatinous. A very remarkable feature may be noticed at this point. Viewed laterally (Fig. 17) the animal bears a striking resemblance to the extraordinary new form described by Joubin (1929 *a*, p. 383) as *Retroteuthis*, in that the velar area has undergone a rotation through about 60–70° and its anterior surface has become largely attached to the dorsal region. The result of this rotation is that, if we imagine the animal orientated with its oral surface downwards in the traditional horizontal plane of the Cephalopod, the mantle aperture instead of being posterior has become dorsal. This is exactly what has happened in Joubin's *Retroteuthis* and also in his *Heptapus* (Joubin, 1929 *b*, p. 13). In that genus Joubin failed to find any indication that the condition is anything else than normal. In this instance I am in practically the same position. Not only is the posture of the body altered in relation to the oral surface, but the web has definitely become concrescent with the dorsal tissues, and ventrally it has become elongated, apparently as a result of (or to meet) the pressure imposed on it by the backward rotation of the visceral mass and head. I do not think this can be caused by accidental distortion or pressure. On the other hand, this form is very gelatinous, and I am not quite clear as to what distortion might occur when a rather heavy gelatinous organism of this kind is kept permanently on a hard surface.

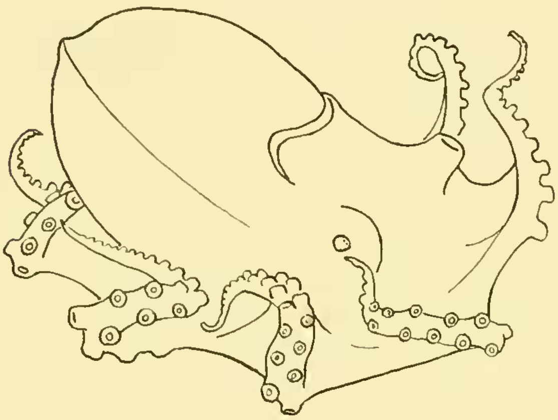


Fig. 17. *Alloposus hardyi*. × *c*. 1·5. (Semi-diagrammatic.)

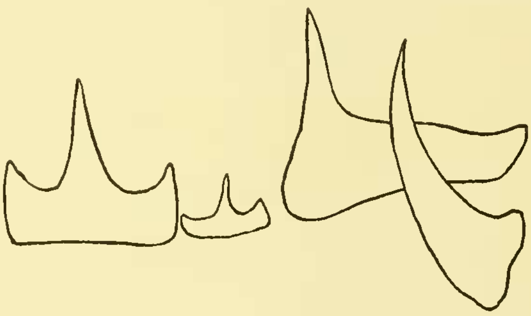


Fig. 18. *Alloposus hardyi*. Radula.

If the rotation is normal, its origin is very obscure. The animal was taken near the surface in water of a depth of 1600 fathoms and must therefore be pelagic. The modification can have no relation, as far as I can see, to crawling on the bottom, and in any case the normal Octopod posture is suited to this. It is noteworthy that *Retroteuthis*, which also shows a similar modification, is quite remotely allied to *A. hardyi*.

The suckers tend to be uniserial or very widely alternating except about and just beyond the margin of the web where they are more or less biserial. They are very prominent but small (6·2 per cent of the mantle length) and extremely weak. Like those of *A. mollis* (Joubin, 1900, pl. v, fig. 14) they are simple, undifferentiated cups, but the walls are everywhere thinner in *A. hardyi*.

The mantle aperture is as in *Alloposina microcotyla* (Hoyle, 1904, p. 9) shaped like a flat W. Its pallial edge is non-adherent. The funnel is mainly incorporated in the head, but there is a free tubular portion about 8–10 mm. long. The shape of the funnel-organ is obscure. Unlike the other forms there are a number of longitudinal folds near the aperture, below which are the remains of what may have been a W-shaped funnel-organ. The gills have six to seven filaments in each demibranch.

The mandibles are unlike those of *A. mollis* (figured by Joubin, 1895, fig., p. 16) in that there is no marked sub-rostral notch. The radula resembles that of *mollis* in general (Joubin, *loc. cit.* pl. v, fig. 11) but differs in sundry details. The shape of the first and third laterals are in particular different. These two species differ markedly from *pacificus* (Sasaki, 1929, p. 18 [*A. pelagicus*] in error) in having bicuspid admedians.

There was no trace of the hectocotylus, but exploration of the mantle cavity revealed the presence of a penis with a long diverticle.

REMARKS. Verrill (1880, p. 393) included in his definition of *Alloposus* the words "mantle united firmly to the *head* by a ventral and two lateral commissures." Hoyle (1886, p. 72) adopted the genus for a "North Atlantic" fragment without questioning the definition. Joubin (1895, 1900 and 1920) does not discuss the latter, though he used the name for various North-east Atlantic fragments. In 1904 (p. 9) Hoyle in discussing the relationship of *Bolitaena* (= *Alloposina*) *microcotyla* does not allude to infundibulo-pallial sutures.

In 1902, however, Ijima (in Ijima and Ikeda, 1902, p. 87, footnote) commented on Verrill's description and said that the median infundibulo-pallial suture seems to be simply a part of the ventro-median septum (median pallial adductor) which is extended far forwards and passes under *but does not join* the ventral edge of the funnel. He also explains away Verrill's "lateral longitudinal commissures."

This feature is not discussed by Berry (1914, p. 286) in his description of the Pacific form of *A. mollis*, nor does he include it in his family and generic definition.

Lastly it is ignored by Sasaki (1929, p. 17) in his description of *A. pacificus*. Naef (1923, figs. on p. 727 and p. 731) describes and figures this infundibulo-pallial suture, but I think purely on the strength of Verrill's account!

It must be admitted that there might be room for confusion here. Thus, we might have grounds for suggesting (*a*) that Verrill was not likely to be mistaken, (*b*) that the subsequent forms, most of them obviously fragmentary, identified as *Alloposus* by Hoyle, Joubin and Ijima[1], etc., were not referable to that genus. In any case no one seems to have troubled to examine the type of *A. mollis*. What grounds have we then for accepting the subsequently described forms as referable to *Alloposus* and foi modifying Verrill's description in an important feature, viz. the siphono-pallial suture?

Actually there is singularly little common ground in the description of Verrill, on the one hand, and of the later writers on the other. Thus Verrill figures the hectocotylus, but this organ is certainly unknown in Berry's specimen and those of the Japanese writers. Joubin and Sasaki figure the radula of the East Atlantic and Japanese (*pacificus*) forms, but it is not known in Verrill's or Hoyle's specimens. Verrill did not describe the funnel-organ. The common factors are the gelatinous tissues, suckers tending to be partly uniserial, wide mantle aperture, deep web and funnel reaching beyond the eyes. We cannot infer from Berry's female specimen if this form has the remarkable

[1] Ijima makes the observation on his *A. mollis* that "there are two buttons at the siphon base, fitting into grooves on the inner surface of the mantle." Sasaki does not mention this Decapod-like trait characteristic of the Argonautidae in his review. There is no "stud and socket" adhesive organ in *A. hardyi*.

Argonautid sex dimorphism or the peculiar hectocotylus. The dimorphism and hectocotylus are not described in *A. pacificus* or in the East Atlantic forms described by Joubin. On the whole this is not a very propitious situation for judging whether the various specimens are congeneric with the type! For the time being I think there is nothing to be done but to be guided by "general facies" and to retain the forms described by Joubin, Hoyle, Sasaki and Berry in *Alloposus*, pending an examination of the type of *A. mollis*.

A. hardyi differs from *A. mollis* (Verrill's description, *loc. cit.* and 1881) in (1) the shape of the mantle-aperture, (2) length of the web, and (3) disposition of the suckers. Furthermore, if we utilise Joubin's description, it differs in (4) details of radula, (5) mandibles, (6) length-ratio arm 1 : arm 4. It differs very clearly from *A. pacificus* in (1) radula (*q.v.*), (2) general build and proportions, (3) length of arms (relative and maximum length), and (4) number of gill lamellae. I have excluded from this discussion the very remarkable rotation of the velar area (comparable to that found in *Retroteuthis*), as I am not wholly satisfied as to the origin of this feature.

BIBLIOGRAPHY

Berry, S. S., 1914. *The Cephalopoda of the Hawaiian Islands.* Bull. U.S. Bur. Fish. Washington, xxxii, p. 257.

—— 1917. *Cephalopoda.* Australasian Antarctic Exp. Sci. Rep. C. iv, pt 2, p. 1.

—— 1918. Postscript to Australasian Antarctic Exp. Sci. Rep. C. iv, pt 2 (1917).

Chun, C., 1900. *Aus den Tiefen des Weltmeeres.* Jena.

Ebersbach, A., 1915. *Zur Anatomie von* Cirroteuthis umbellata.... Z. wiss. Zool. Leipzig, cxiii, 3, p. 361.

Hoyle, W. E., 1885. *Diagnoses of new species of Cephalopoda.* Ann. Mag. Nat. Hist. Ser. 5, xv, p. 222.

—— 1886. *Cephalopoda.* Report...H.M.S. 'Challenger.' Zoology, xvi, pt 44.

—— 1904. *Reports on the Cephalopoda...'Albatross'* (1899–1900). Bull. Mus. Comp. Zool. Harvard, xliii, p. 1.

—— 1912. *Cephalopoda of the Scottish National Antarctic Expedition.* Trans. Roy. Soc. Edinb. xlviii, pt ii, p. 273.

Ijima, I. and Ikeda, S., 1902. *Notes on a specimen of* Amphitretus. Ann. Zool. Jap. iv, pt iii, p. 85.

Joubin, L., 1895. *Contributions à l'étude des Céphalopodes de l'Atlantique Nord.* Rés. Camp. Sci....Albert, i, fasc. ix.

—— 1900. *Céphalopodes provenant des campagnes de la 'Princesse Alice.'* Rés. Camp. Sci....Albert, i, fasc. xvii.

—— 1905. *Description de deux Élédones.* Mém. Soc. Zool. France, xviii, p. 22.

—— 1906. *Expédition Antarctique Française (Sci. Nat. Doc. Sci.); Céphalopodes.*

—— ? 1914. *Deuxième Expéd. Antarctique Française; Céphalopodes.*

—— 1918. *Étude préliminaire sur...*Vitreledonella Richardi. Bull. Inst. Océanogr. Monaco, No. 340.

—— 1920. *Céphalopodes provenant des campagnes de la 'Princesse Alice.'* Rés. Camp. Sci....Albert, i, fasc. liv.

—— 1924. *Contribution à l'étude des Céphalopodes de l'Atlantique Nord* (4). Rés. Camp. Sci....Albert, i, fasc. lxvii.

—— 1929. *Notes préliminaires sur les Céphalopodes des croisières du 'Dana.'* Ann. Inst. Océanogr. Paris, (*a*) vi, fasc. iv, p. 363; (*b*) vii, fasc. i, p. 1.

Massy, A. L., 1916. *Mollusca, II, Cephalopoda.* British Antarctic ('Terra Nova') Expedition, 1910, Zoology ii, p. 141.

Naef, A., 1923. *Die Cephalopoden.* Fauna e Flora del Golfo di Napoli, Monogr. 35.

Odhner, N., 1923. *Die Cephalopoden.* Zool. Res. Swedish Antarctic Exp. i, No. 4, p. 1.

Robson, G. C., 1924. *On new species, etc., of Octopoda from South Africa.* Ann. Mag. Nat. Hist. Ser. 9, xiii, p. 202.

—— 1924 *a. On the Cephalopoda obtained in South African Waters.* Proc. Zool. Soc. London, p. 589.

—— 1926. *The Deep Sea Octopoda.* Proc. Zool. Soc. London, p. 1323.

—— 1928. *On the giant Octopus of New Zealand.* Proc. Zool. Soc. London, p. 257.

—— 1929. *A Monograph of the Recent Cephalopoda.* Part i, London (British Museum).

—— 1929 *a. Notes on the Cephalopoda*, IX. Ann. Mag. Nat. Hist. Ser. 10, iii, p. 609.

—— 1930. *Notes on the Cephalopoda*, X. Ann. Mag. Nat. Hist. 10, v, p. 239.

—— 1930 *a. Notes on the Cephalopoda*, XI. Ann. Mag. Nat. Hist. 10, v, p. 330.

Sasaki, M., 1917. *On the male of* Amphitretus pelagicus. Ann. Zool. Jap. ix, pt iii, p. 361.

—— 1929. *A Monograph of the Dibranchiate Cephalopods of the Japanese and adjacent waters.* Journ. Coll. Agric. Hokkaido, Imp. Univ. xx, Supplementary Number.

Thiele, J., 1915. In Chun. *Wiss. Ergebn. Deutsche Tiefsee Exp.* xviii, ii (passim).

Verrill, A. E., 1880. *Notice of the remarkable Marine Fauna...New England.* Am. Journ. Sci. Arts (3), xx, p. 390.

—— 1881. *The Cephalopods of the North-eastern Coast of America.* Trans. Conn. Acad. Sci. v, pp. 366, 420.

—— 1885. *Third Catalogue of Mollusca...New England Coast.* Trans. Conn. Acad. Sci. vi, p. 395.

PLATE III

Fig. 1. *Graneledone polymorpha*, n.sp. Nat. size. (Type.)

Fig. 2. *Amphitretus thielei*, n.sp. $\times \frac{5}{8}$. (Type.)

2.

1.

A. J. E. Terzi, del.

John Bale Sons & Danielsson, Ltd London

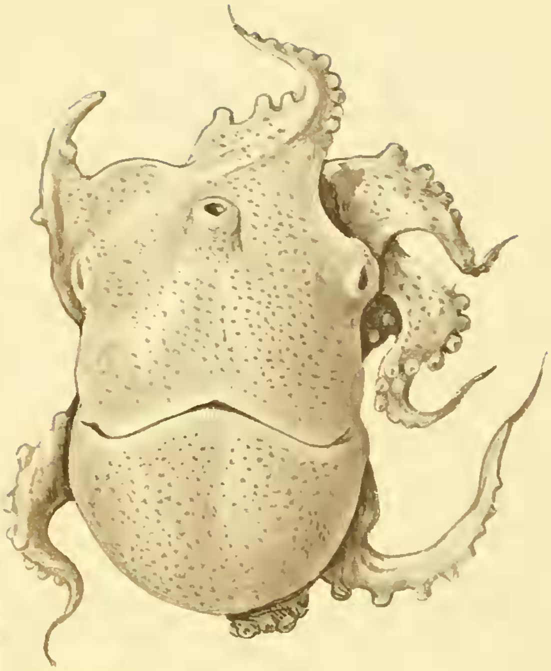
CEPHALOPODA I, OCTOPODA

PLATE IV

Fig. 1. *Alloposus hardyi,* n.sp. Nat. size. (Type.)

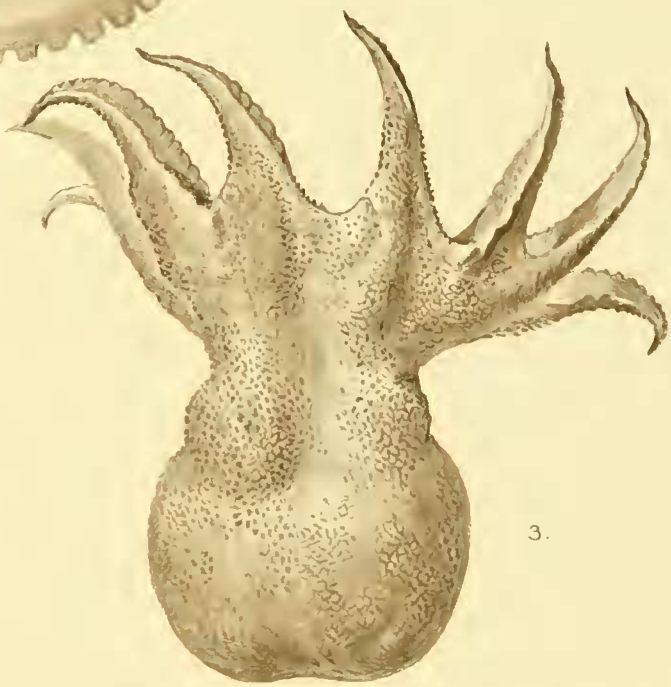
Fig. 2. *Benthoctopus* sp. Nat. size.

Fig. 3. *Thaumeledone gunteri*, n.sp. Nat. size. (Type.)



1.

2.



3.

A. J. E. Terzi, del

CEPHALOPODA I, OCTOPODA